

Part I

APPENDIX F. SUPPLEMENTARY MAGNETIC PARTICLE TESTING PROCEDURES

Scope

This appendix supplements Part I, Section 6.7.1 and provides guidelines for preparation of procedures for magnetic particle testing (MT).

Written Procedures

Written MT examination procedures shall be prepared by the Quality Assurance Agency responsible for nondestructive testing, and approved by the designated party responsible for the Quality Assurance Plan. The procedures shall be developed considering the geometry of the work to be inspected, yoke application, light levels, accessibility, and safety.

The following items shall be detailed in the written procedure:

1. type of weld to be examined,
2. type of magnetizing equipment, including type of current employed,
3. surface preparation,
4. examination sequence,
5. magnetization plan,
6. magnetic field direction,
7. magnetic field strength at inspection location,
8. magnetic particle type and color,
9. interpretation of indications,
10. acceptance criteria, and
11. reporting forms and procedures.

Procedure Evaluation

An evaluation of the system performance and sensitivity shall be demonstrated prior to the beginning of any testing work. A magnetic particle test bar shall be used to verify sensitivity to a depth of 1/8 inch. This requirement shall be included within the written procedure.

Method

Prior to MT, the weld shall be inspected visually for detection of gross imperfections. The inspected surface shall be cleaned where necessary.

The continuous method, using an alternating current (AC) electromagnetic yoke (double leg or single leg configuration) with dry white-light-visible magnetic particles, may be used as a preliminary examination. Rectified AC (that is, DC) and residual induction methods may also be employed for preliminary examination.

Final examination shall use DC current of the strength required to achieve a depth of examination of 1/8 inch. The examination shall take place while the magnetizing current is on, including application of particles, removal of excess particles, and indication interpretation.

Yoke

The yoke shall be of the articulating-leg rectified AC (DC) type to allow for the inspection of various geometries. A single-leg yoke may be used in areas of tight access. Fixed-leg yokes are not permitted. Rectified AC (DC) yokes shall have a minimum lifting power of 40 pounds when the legs are spaced at the inspection distance. Yokes shall be routinely tested to ensure that the required magnetization performance and sensitivity levels are met during inspection.

Magnetization

A magnetizing current at 50 to 60 Hertz AC electromagnetization may be used for detection of surface-breaking discontinuities. System sensitivity shall be checked with a suitably located pie gauge. The current shall then be changed from AC to rectified AC (DC) for deeper penetration of the magnetizing field into the part.

Particles

The magnetic particles shall be dry, finely divided high-permeability ferromagnetic material with low retentivity and a suitable size range. The particles shall have 75 percent (by weight) particles finer than a 120 ASTM sieve mesh, a minimum of 15 percent (by weight) dry particles being finer than a 325 ASTM sieve mesh. Their color shall provide high contrast to the background on which applied. Particles shall be free from rust, fillers, or other material that could interfere with their use. Magnetic particle materials shall be used only once.

Particle application and removal equipment (powder bulbs, aerosol sprays) shall be such that fine indications are not removed by excessive force.

Lighting

Adequate light shall be present for observation of particle indications. A minimum of 100 foot-candles (1000 lux) shall be present at the inspection location, measured with a calibrated light meter.

Surface Condition

The surface shall be cleaned to bare metal prior to magnetic particle testing by grinding, wire brushing, hand scraping, or a combination of these. Welds shall be dry and free from foreign materials such as dirt, grease, rust, and excessive weld spatter. A thin, light coating of contrasting paint may be applied to assist in the detection of smaller imperfections.

Equipment Performance Checks

The performance and sensitivity of the magnetic particle inspection system and procedures shall be checked at regular intervals. The following parameters shall be checked each day, prior to performing any examination, and shall be documented:

1. yoke magnetizing strength,
2. sensitivity to imperfections at a depth of 1/8 inch, using a test bar,
3. yoke set-up,
4. magnetizing field direction,
5. magnetic particle performance, and
6. particle removal force, using standard samples with discontinuities.

Yoke Placement

Examination shall be conducted with sufficient overlap to ensure 100% coverage. However, if the geometry of the piece does not permit 100% evaluation of the piece, this shall be stated on the test report.

For inspection for discontinuities in the longitudinal direction, the yoke shall be placed astride and perpendicular to the weld. The yoke legs shall be positioned such that they are approximately 1/2 inch from the toe of the weld. The effective area of inspection is between the yoke legs, with a lateral area of approximately 1-1/2 inches on either side of the centerline between the yoke legs. The total length weld coverage for one position of the yoke is approximately 3 inches. Sufficient overlap should be used to ensure 100% coverage when moving along the weld length. Yoke movement in 2-inch intervals should ensure adequate overlap.

For inspection for discontinuities in the transverse direction, the yoke shall be oriented so that the yoke legs are approximately parallel to the weld, approximately 1/2 inch from the toe of the weld. If the yoke has to be placed on top of the weld to gain access, the technician should ensure the best contact possible of the yoke legs to the weld. The effective area of inspection is between the yoke legs, with a 4-inch leg spacing recommended. Sufficient overlap may be achieved by moving the yoke to a position which overlaps the last position by at least 1 inch.

Particle Application and Removal

Dry particles shall be applied in such a manner that a light, uniform, dust-like coating of particles settles on the part while it is being magnetized. Particle indications shall be observed when being formed as the particles are being applied, and while the excess particles are being removed.

Sufficient air velocity for particle removal must be directed at the area of inspection to remove the excess particles entrapped in areas such as weld undercuts, while retaining the particles held by magnetic flux leakage from any discontinuities.

Interpretation and Evaluation of Indications

Relevant magnetic particle testing indications are those that result from magnetic flux leakage fields formed by discontinuities that attract and hold magnetic particles. False indications are those held primarily by nonmagnetic means such as mechanical entrapment in the toe of a weld. Nonrelevant indications are those particles held in place by magnetic attraction, but not originating from a structural discontinuity such as the boundary of two steels having significantly different magnetic properties or the boundary at the hardened heat-affected zone of a weld.

Testing personnel shall verify indications by performing the following steps:

1. Retest with the yoke field perpendicular to the discontinuity indication, if not already perpendicular.
2. Retest, confirming that excess particles are removed. If the suspect indication is removed during the retest, the indication is interpreted as nonrelevant or as a false indication.
3. If the indication has a light particle buildup and weak particle adhesion, and if doubt exists as to whether the indication is relevant or false, the area of the indication shall be lightly surface-ground and retested.